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Original article

# Traumatic diaphragmatic rupture: associated injuries and outcome

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**A retrospective case note analysis was performed on all patients treated for traumatic diaphragmatic rupture (TDR) at a major teaching hospital between January 1990 and August 1998. Patients were identified from the prospectively maintained UK Trauma and Research Network Database. Of the 480 cases of torso trauma admitted during the study period, 16 (3.3%) had TDR. Blunt trauma accounted for 13 (81%) of the injuries. A radiological pre-operative diagnosis was made in 10 (62.5%) patients. Seven of these were made on initial chest radiography, two on ultrasound scan and one on computed tomography. All patients underwent a midline laparotomy and TDR was subsequently diagnosed at operation in 6 patients. The left hemidiaphragm was ruptured in 14 (87.5%) patients and there was visceral herniation in 8 (50%). Twelve patients with blunt trauma had associated abdominal and extra-abdominal injuries, but only one of the three patients with penetrating trauma had other injuries. The median Injury Severity Score (range) was 21 (9–50). The median time (range) spent on the intensive care unit was 2 days (0–35 days). Pulmonary complications occurred in 7 (44%) patients. Two (12.5%) patients died from associated head injuries. TDR results from blunt and penetrating torso trauma, is uncommon, rarely occurs in isolation and is associated with a high morbidity and mortality. A high index of suspicion makes early diagnosis more likely as initial physical and radiological signs may be lacking.**

*Key words:* Diaphragmatic hernia – Multiple trauma – Abdominal injuries – Rupture – Accidents

Traumatic diaphragmatic rupture (TDR) is a rare injury that occurs secondary to both blunt and penetrating torso trauma and is associated with a mortality of up to 19%.[1,2] Deformation shear of the diaphragm is thought to be important factor in the pathogenesis of the condition after blunt trauma.[3] The injury is, therefore, seen after high-energy impact, especially side impact, and is usually associated with other serious and often life threatening injuries.

We present our experience of 16 patients treated for TDR at a major teaching hospital and emphasise the

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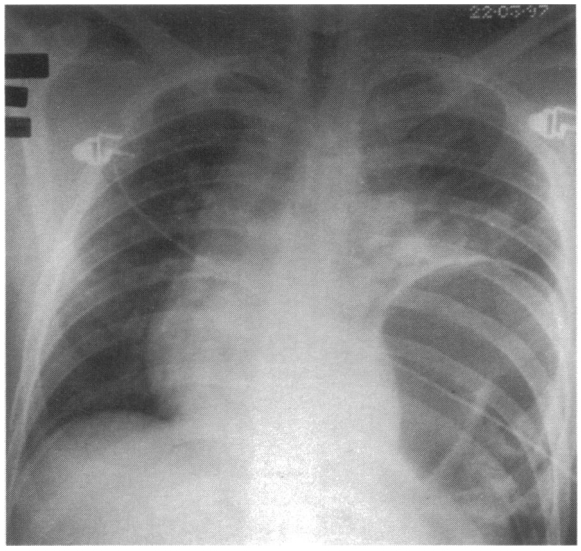

**Figure 1** Supine chest radiograph showing visceral herniation into the left hemithorax.

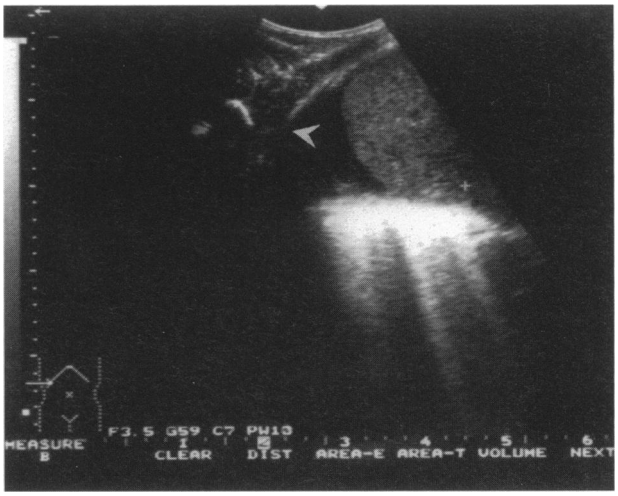


**Figure 2** Abdominal ultrasonogram revealing a defect (arrow) in the right hemidiaphragm.

importance of inspection of both domes of the diaphragm during a laparotomy for trauma.

## Patients and Methods

A retrospective case note analysis was performed on all patients treated for diaphragmatic injuries at University Hospital, Nottingham, UK between January 1990 and August 1998. Patients were identified from the prospectively maintained UK Trauma and Research Network Database, which records all injuries sustained, including those detected at autopsy.

## Results

During the period of the study, TDR was identified in 16 of 480 patients (3.3%) who were admitted with abdominal and/or thoracic trauma. Twelve of the 16 patients were male and the median age was 21 years (range 8–61 years). Blunt trauma accounted for 13 (81%) cases. Of these, 12 were the result of road traffic accidents (3 driver, 6 passenger and 3 pedestrian) and one was caused by a 10 m fall down a mineshaft. Two of the penetrating wounds were due to stab injuries and the other was the result of impalement on a fence.

All patients underwent a laparotomy. A pre-operative diagnosis was made in 10 (62.5%). Seven of these were diagnosed on chest X-ray (CXR) (Fig. 1) and a further three suspicious CXRs were followed up with ultrasound scans in two (Fig. 2) and computerised tomography (CT) in one (Fig. 3A,B) which confirmed the diagnosis. TDR was first diagnosed in the remaining six patients, who had clinical indications for laparotomy but no pre-operative radiological evidence of diaphragmatic rupture, on careful intra-operative inspection of the domes of the diaphragm.

At laparotomy, the left hemidiaphragm was ruptured in 14 (87.5%) patients. There was visceral herniation into the thorax in 8 (50%) patients. All these were left sided and had been identified pre-operatively with imaging. The stomach was herniated in all eight patients. In addition, the spleen and small bowel were herniated in one, small bowel in two and the colon in four. The

*Table 1 Associated injuries*

| Injuries | Number *n* (%) | |
|---|---|---|
| *Intra-abdominal injuries* | | |
| Splenic lacerations | 4 (25) | [2 splenectomies] |
| Liver lacerations | 3 (19) | |
| Perinephric haematoma | 1 (6) | |
| Gastric perforation | 1 (6) | |
| Transection of distal pancreas | 1 (6) | |
| Gallbladder avulsion | 1 (6) | |
| *Extra-abdominal injuries* | | |
| Pelvic fractures | 7 (44) | |
| Long bone fractures | 6 (38) | |
| Multiple rib fractures | 4 (25) | |
| Head injury | 4 (25) | [2 deaths] |

One patient with penetrating trauma had a splenic laceration, gastric perforation, transection of tail of pancreas and left perinephric haematoma in addition to the diaphragmatic rupture. All other associated injuries were seen in patients sustaining blunt trauma.

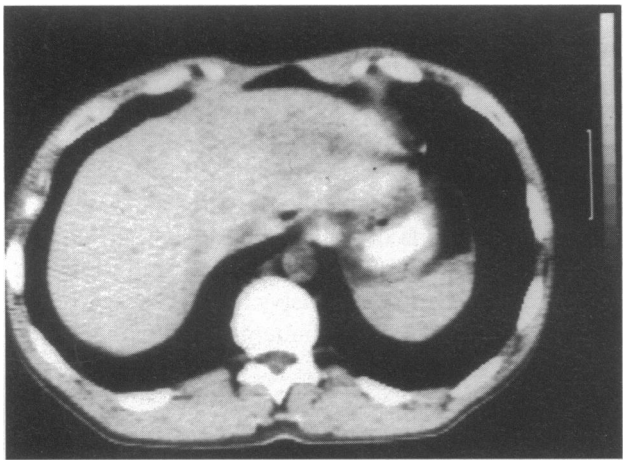

**Figure 3** (**A**) Normal thoraco-abdominal CT scan showing linear air shadow around the liver.

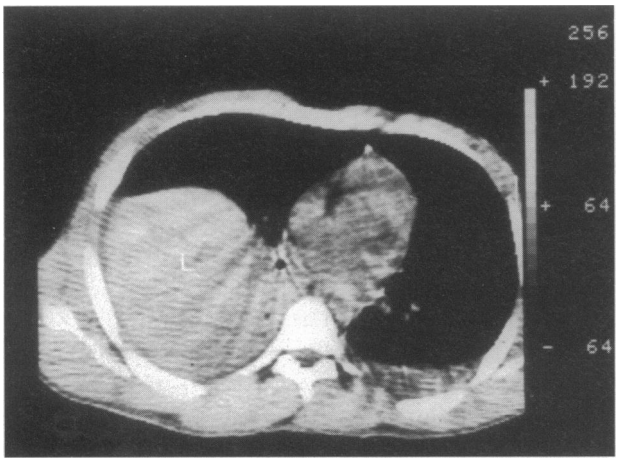


**Figure 3** (**B**) Thoraco-abdominal CT scan in a patient with a ruptured right hemidiaphragm. Loss of the perihepatic air shadow is indicative of a diaphragmatic injury.

ruptures were all repaired primarily, using single layer, interrupted non-absorbable monofilament sutures. Twelve patients with blunt trauma had associated abdominal and extra-abdominal injuries (Table 1), but only one of the three patients with penetrating trauma had other injuries. Four patients with pelvic fractures underwent further operations for open reduction and internal fixation of their fractures. In addition, three patients required operative management of femoral fractures and four patients required further general anaesthetics for inspection and debridement of soft tissue injuries.

The median Injury Severity Score (ISS)[4] was 21 (range: 9–50). The two deaths occurred in patients with severe head injuries, both having an ISS of 50. The probabilities of survival in these patients were 0.11 and 0.37, and therefore the deaths were not unexpected. The median time spent on the intensive care unit was 2 days (range 0-35).

There was significant morbidity associated with these patients (Table 2). Pulmonary complications occurred in 7 (44%) patients and some of the complications were related to extra-abdominal injuries and operations performed to tackle these injuries.

## Discussion

TDR is a relatively rare accompaniment to torso trauma and is usually associated with other injuries, especially when due to blunt trauma. Concentration on other injuries sustained and inconsistency of signs on imaging can often lead to a missed diagnosis of TDR and inspection of both domes of the diaphragm at laparotomy for trauma is mandatory.

In a review of 980 cases, the injury was 4 times more common in males and usually occurred in the 3rd decade of life.[1] Blunt trauma was responsible for 75% of cases. Left-sided ruptures accounted for 68.5% of cases, 24.2% occurred on the right, 1.5% were bilateral, 0.9% were pericardial and 5% were unclassified. The vast majority of TDR seen in the UK is due to blunt trauma, mainly because of the relative rarity of penetrating stab and firearm injuries. There is a high incidence of associated injury, most commonly chest

*Table 2 Postoperative complications*

| Complications | Number (*n*) |
|---|---|
| Pulmonary | |
| Infection | 3 |
| Adult respiratory distress syndrome | 2 |
| Persistent pneumothorax | 1 |
| Fat embolism | 1 |
| Neurological | |
| Speech impairment | 1 |
| Diffuse motor impairment | 1 |
| Spinal epidural abscess | 1 |
| Epilepsy | 1 |
| Re-operations | |
| Thoracotomy for persistent bleeding | 1 |
| Thoracic laminectomy + drainage of spinal epidural abscess | 1 |
| Others | |
| Pelvic abscess drained spontaneously into rectum* | 1 |
| Acute renal failure | 1 |
| Gluteal fat necrosis | 1 |

*This complication was seen in a patient with penetrating trauma. All other complications occurred in patients with blunt trauma.

(43.9%), pelvic (40%), splenic (37.6%), and liver (25%). Visceral migration may occur in 33% of patients and the mortality can be as high as 17–19%.[1,2]

There is no single investigation that provides a reliable diagnosis of TDR at initial presentation. Between 33–70% are diagnosed on initial CXR, but this figure decreases in patients who are intubated.[5] The remaining cases are diagnosed at laparotomy, thoracotomy or autopsy and around 12–14% of cases have a delayed presentation.[1,6] The accuracy of CXR diagnosis is enhanced by the presence of visceral herniation, but a haemothorax or concurrent lung disease can obscure a rupture. CT scanning increases diagnostic sensitivity to 66%.[7] Magnetic resonance imaging, ultrasound,[6] upper gastrointestinal contrast studies, laparoscopy and thoracoscopy[8] have all been used in the diagnosis of TDR.

Spontaneous closure of the diaphragmatic tear is unlikely because of the abdominothoracic pressure gradient, and progression to enlargement of the defect and thoracic herniation of the intra-abdominal contents can be expected. Acute ruptures are best approached transabdominally via a midline incision as this permits assessment of associated intra-abdominal injuries. Diaphragmatic ruptures presenting in the latent phase, which can be from a few months to several years later, are more easily approached through the chest. This provides good access to the sac, as adhesions between the abdominal and intra-thoracic viscera may need to be broken down. Usually the ruptures can be re-approximated and repaired primarily. However, larger defects have been closed using prosthetic material.[9]

Diagnostic delay can lead to long-term sequelae that can present from a few days to many years following the injury. Recognised complications are respiratory compromise due to a volume effect, pleural collection, pneumoperitoneum and intestinal obstruction or strangulation.

Patients sustaining high energy or penetrating thoraco-abdominal injuries are at risk of TDR. The ISS following an isolated diaphragmatic rupture is 9, which correlates with a probability of survival coefficient of 0.99.[4] However, there is a high incidence of associated life threatening injuries particularly following blunt trauma and morbidity and mortality are usually due to these. The occurrence of associated injuries in patients with penetrating trauma is variable and is largely dependent on the nature (e.g. knife or firearm), velocity and path of the weapon or projectile.

In the absence of respiratory compromise or initial radiological signs the diagnosis can be overlooked. As diagnostic delay is associated with an increased morbidity,[3] it is important to identify the problem as early as possible. Initial radiological signs are often lacking (especially with right-sided lesions) and, if a laparotomy is not performed or deferred, there should be a low threshold for using further imaging to assess the diaphragm. When a laparotomy is performed, meticulous inspection of both domes of the diaphragm is essential. The importance of this is borne by the fact that 37.5% of TDRs were diagnosed at laparotomy in this series. Death is usually due to associated injuries and the high morbidity is mainly due to pulmonary complications. One has to suspect and actively look for the injury when managing patients with torso trauma!

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